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Dynamical nuclear polarization and confinement effects in ZnO quantum dots

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Abstract

The spatial distribution of the electronic wave function of a shallow donor (SD) in a ZnO semiconductor quantum dots (QD's) has been determined in the regime of quantum confinement by using the nuclear spins as probes. Hyperfine (HF) interactions as monitored by electron nuclear double resonance spectroscopy quantitatively reveal the transition from semiconductor to molecular properties upon reduction of the size of the nanoparticles. Influence of confinement effect on g-factor value of SD's in ZnO and CdS QD's was displayed. The almost complete dynamic nuclear polarization (DNP) of nuclear spins has been demonstrated can be achieved in ZnO QD's by saturating the EPR transition of the SD present in the QD's with using high-frequency at low temperatures. Polarization of 67Zn nuclear spins in ZnO core and of 1H nuclear spins in the Zn(OH) 2 capping layer have been obtained which manifests itself via the creation of a hole and an antihole in the EPR absorption line of the SD in QD's and a shift of the hole (antihole). The enhancement of the nuclear polarization opens the possibility to study semiconductor nanostructures with NMR techniques.

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Keywords

Defect levels, Electron paramagnetic resonance, II-VI semiconductors